



TEERM Overview

Risk Mitigation and Opportunities through Partnerships

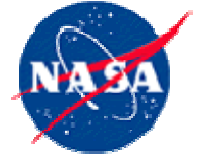


NASA Environmental & Energy Conference

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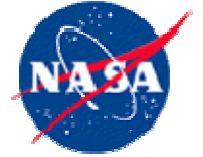
Presenter: Charles Griffin, TEERM Manager



Agenda

- NASA TEERM Principal Center Overview
 - Mission & History
 - Project Process
 - Projects
 - Partners
 - Value & Successes
 - Future Direction





TEERM Mission & History



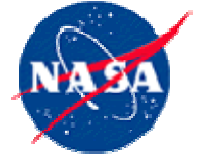
TEERM Mission & History

- NASA KSC is the Principal Center for TEERM.
 - NASA Headquarters established TEERM (formerly the NASA Acquisition Pollution Prevention (AP2) Program Office) in 1998 to help NASA Programs and Centers identify and validate **environmental** technologies through joint activities that enhance mission readiness and reduce risk while minimizing duplication and associated costs.
 - NASA AP2 was a spin-off of the DoD's Joint Group on Pollution Prevention (JG-PP) (chartered by the Joint Logistics Commanders in 1994)
 - JG-PP formed to address DoD's concern that services (especially OEMs) were duplicating efforts when it came to qualifying new, environmentally preferable materials or processes.



TEERM Mission & History

- In 2007, AP2 changed to TEERM — Technology Evaluation for Environmental Risk Mitigation — to highlight new focus:
 - TEERM role in *evaluating technologies*
 - TEERM role in mitigating *environmentally-driven risk to mission*. By reducing risk to mission, TEERM is also helping NASA reduce risks to the environment.
 - Hexavalent chromium → Surface coatings → Compliance costs increasing
 - Lead → Electronic soldering and surface finishes → COTS parts going lead-free, but lead-free reliability questionable
 - Isocyanates → Components of coatings on launch pads and ground support → Use is banned or restricted by NASA Centers



Project Process



TEERM Project Process

- Key elements of TEERM's approach
 - Lead NASA efforts to identify and test environmentally preferable alternative materials and processes
 - Identify materials/processes
 - Manage joint testing (“dem/val”) projects
 - Advocate for funding for testing
 - Prepare reports and disseminate test results
 - Execute follow-through to next logical step:
 - Technology implementation
 - Further dem/val
 - Go back to R&D
 - Develop risk mitigation options



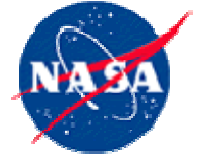
TEERM Project Process

- TEERM Project Financial Strategies
 - Stakeholder participation in a TEERM dem/val project is voluntary and at their own expense.
 - However, government program managers are requested to help provide funding for validation testing of alternatives.
 - TEERM and its support contractor, ITB, provides significant support at no cost to the affected program manager.
 - Implementation costs are the responsibility of the affected defense or space contractor and/or program.



TEERM Project Process – Benefits

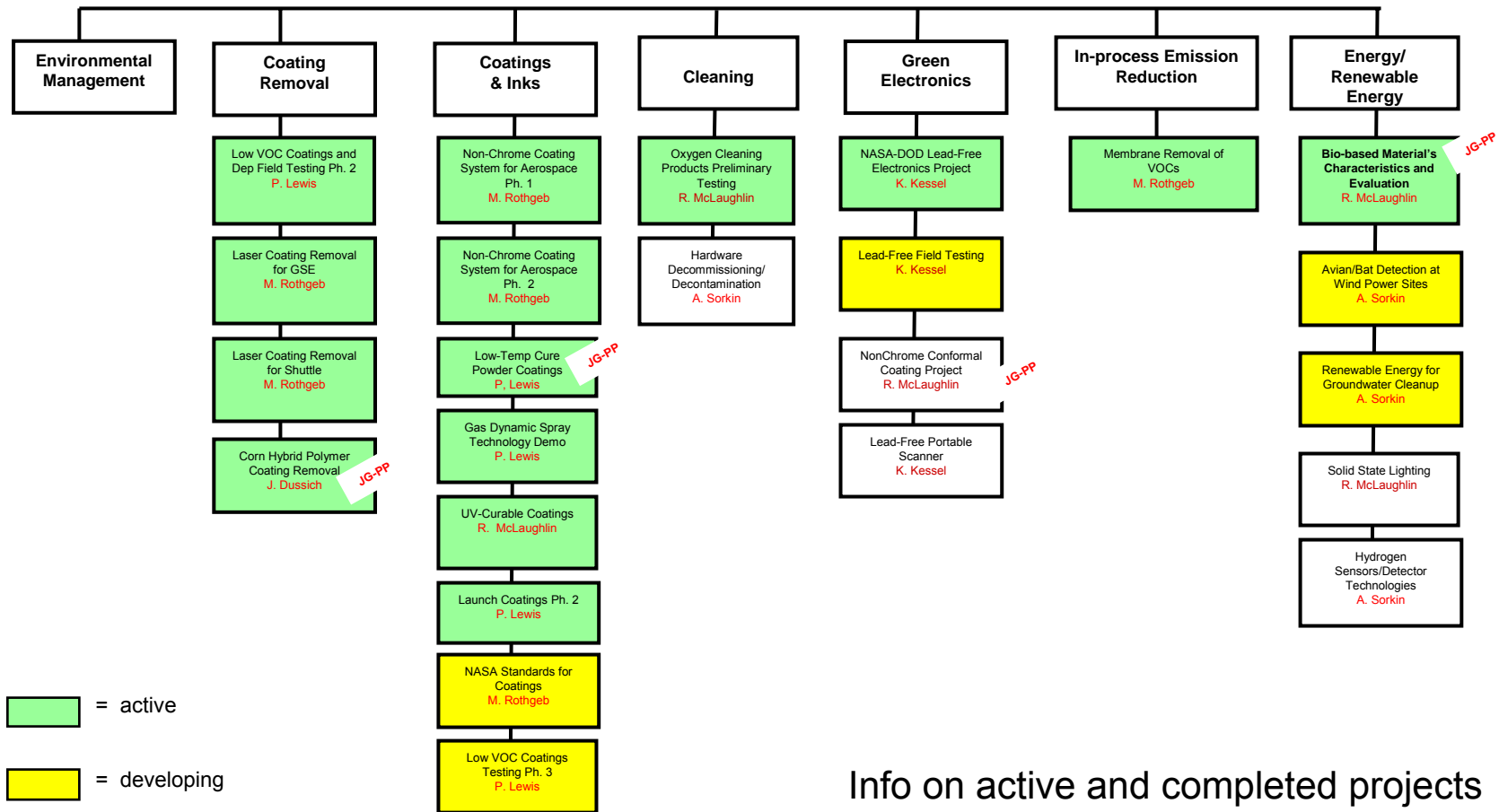
- TEERM methodology is flexible to account for the different needs of contractors and programs
- Products (reports, etc.) are easily customized to meet customers needs.
- TEERM is a resource to the project team for technical and business support
- TEERM assists in identifying resources for validation testing of alternatives
- Cost effective



Projects



TEERM Work Breakdown Structure - Active and Developing Projects



Info on active and completed projects is available on the TEERM web site, www.teerm.nasa.gov



Partnering



TEERM Partnering

- Examples of TEERM project partners:
 - NASA Centers
 - Industry contractors (domestic or international)
 - Affected NASA space system and Army, Navy, Marine Corps, and Air Force defense system program managers and maintenance process owners
 - Defense Logistics Agency (DLA).
- A key requirement for TEERM to start a project is commitment from two or more entities to participate, with one party being NASA or NASA contractor.



TEERM Partnering

- Why TEERM collaborates with other Agencies and with industry:
 - Helps improve NASA's ability to adopt new material to reduce unacceptable mission risks in a more proactive and cost effective manner.
 - Sharing of resources reduces the cost to test and qualify alternatives
 - Historical 3:1 leveraging of NASA's investment in projects.
 - Enhances technical confidence
 - Avoids duplication of effort among different parties.
 - Improves the overall technical quality of the effort through knowledge sharing.
 - Accelerates implementation of qualified alternatives.
 - Helps NASA better position itself to respond to new global regulatory and business paradigms.



TEERM Partners within NASA

- ***Shuttle Environmental Assurance (SEA) Initiative***
 - Working on a “Lessons Learned” document regarding hexavalent chrome coatings and cadmium plating for new programs.
- ***KSC Corrosion Laboratory***
 - Testing partner and subject matter expert on many TEERM corrosion/ coatings projects.
- ***NASA Electronics Parts and Packaging (NEPP) at GSFC***
 - Worked together to address lead-free electronics issues.
- ***Regulatory Risk Analysis and Communication (RRAC) Principal Center***
 - Benefits through identification of future risks to mission.
- ***Orion Surface Finishes Team***
 - Test and evaluate for design the corrosion protection finishes for the entire Orion vehicle.



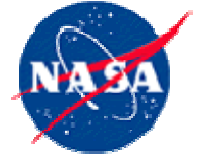
TEERM Partners within DoD

- ***Air Force Space Command***
 - Coatings: volatile organic compounds and hexavalent chrome.
 - Depainting: particulate emissions and hazardous waste.
- ***U.S. Air Force***
 - Coatings: volatile organic compounds and hexavalent chrome
 - Laser coating removal
 - Lead-free electronics
- ***U.S. Navy***
 - Biobased fluids
- ***NAVSEA Crane and Defense Micro-Electronics Activity (DMEA)***
 - Lead-free electronics
- ***JG-PP***
 - Encompasses all of the interest areas noted above, plus others



TEERM Partners Internationally

<i>Current Signatories to C3P Protocol</i>	<i>Interest</i>
• National Association of Electric and Electronic Manufactures (ANIMEE), Portugal	Lead-free solder
• TAP Air, Portugal	Low-VOC/Non-Chrome Coatings
• OGMA – Aeronautical Industry of Portugal	Low-VOC/Non-Chrome Coatings
• BAE, U.K.	Chrome-free coating systems and Lead-free solders
• Portuguese Air Force	Chrome-free coating systems
• INASMET, Spain	Lead-free solders and testing lab
• SetCom, Portugal	Lead-free solders
• Israel Aircraft Industries	Lead-free solders



TEERM Value and Successes

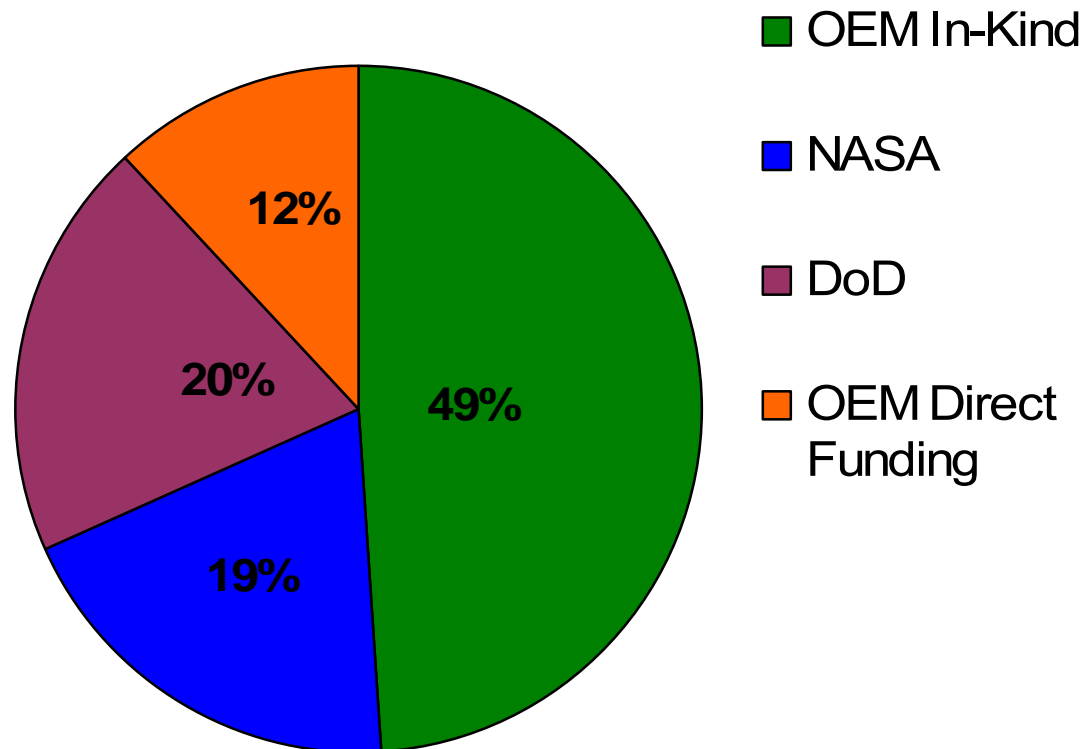


TEERM Value & Successes

- Sharing or resources reduces cost to test and qualify alternatives

Example:

– NASA-DoD Lead-Free Electronics Project – Contributions



5:1 Leveraging of
NASA's investment



TEERM Value & Successes

- Enhanced technical confidence in alternatives identified and tested
 - Example: Portable Laser Coating Removal (PLCR) Project (completed project)
 - Original JG-PP project (>\$5M, multi-service [Air Force -led], multi-year effort, but limited NASA involvement) validated PLCR; PLCR installed at Air Force bases
 - As follow-on to JG-PP, TEERM orchestrated two demonstrations of PLCR at NASA GRC and KSC.
 - Was able to utilize existing JG-PP JTP and Air Force Safety Plan to more quickly get PLCR approved for demonstration at NASA
 - Over 100 components and test panels were tested.
 - Determined that PLCR holds promise for non-destructive evaluation testing for weld-line inspections, corrosion removal, and small-area applications where blast media is not permitted.



TEERM Value & Successes

- Avoids duplication of effort among parties
 - Example: Nonchrome Coating System Project (active project [Phase 2])
 - TEERM-led project involving multiple organizations within NASA and DOD
 - Various parties contributing to Joint Test Protocol (almost complete)
 - Air Force and Ares Upper Stage are donating materials and coatings
 - MSFC doing in-kind lab testing
 - Coordinated effort with NASA and DOD groups (Orion Surface Finishes Team, Air Force) so as not to unnecessarily duplicate efforts and so that TEERM results valuable to Orion and Air Force.



TEERM Value & Successes

- Improves the technical quality of the effort through knowledge sharing
 - Example: Lead-Free Solder Project Joint Test Protocol (1st project completed, 2nd project ongoing)
 - Project involved dozens of leading experts from domestic and international defense contractors who have conducted solder testing in the past
 - Project's JTP took more than 2 years for the team to complete, but now is recognized as a world-wide guidance for conducting lead-free solder testing
 - » The TEERM project won the international Soldertec award for team excellence in lead-free electronics.
 - Data from the 1st project is being used by:
 - researchers in their mathematical models to predict lead-free reliability
 - authors of specifications and other electronics industry standards
 - Project is referenced in Air Force's air worthiness advisory



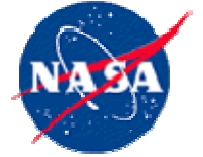
TEERM Value & Successes

- Accelerates implementation of qualified alternatives
 - Example 1: NASA-AFSCP launch complex coatings project (completed project)
 - After extension lab and beach testing, five low-VOC, chromium-free coating products were qualified and added to Qualified Product List (QPL).
 - Example 2: Parts Washer Project (completed project)
 - Several parts washers and cleaning solutions were tested at NASA Centers and verified in independent lab testing. TEERM's donation of engineering time and the fact that no direct funding was required from NASA fast-tracked the dem/val.
 - At completion of TEERM project, at least seven modern parts washers were procured or planned to be procured by NASA shops, reducing environmental waste at each location.



TEERM Value & Successes – Lessons Learned

- Sharing of P2 problems and successes among Centers and Programs is very important.
- Government/industry partnerships are key to success. Partnerships result in less duplication of effort and cost for the program/Agency as a whole.
- The earlier the collaboration on common issues, the more beneficial the outcome.
- Implementing P2 solutions during the design phase of a program benefits both the suppliers and program operations & maintenance costs.



Future Direction



TEERM Future Direction

- New Efforts and Possibilities
 - Consider niche applications. Examples:
 - Portable laser coating removal (replacement for spot hand sanding)
 - Gas dynamic (“cold”) spray as alternative to thermal spray
 - Efforts of lower technology readiness (TRL <5). Examples:
 - Green chemistry for oxygen system cleaning
 - Halon 1201 alternatives (JG-PP -proposed)
 - Greenhouse gas reduction (incl. renewable energy) efforts
 - Renewable energy coupled with groundwater cleanup
 - Biobased materials characteristics and evaluation (JG-PP)
 - Solid state (LED) lighting for indoors
 - Avian/bat detection at wind power sites
 - Hydrogen sensors/detector technologies (for fuel cell sites, etc.)



TEERM Future Direction

- Continued Efforts and Possibilities
 - Enhanced international collaboration
 - Incorporating REACH and other international directives in TEERM project selection process
 - Identifying common NASA-European Space Agency P2 needs
 - Developing a binding agreement between NASA and Portugal
 - Technology and risk mitigation assessments
 - State-of-technology assessment for alternatives to chromium in coatings (JG-PP effort)
 - Analysis of Shuttle Program's cost to evaluate and abate tin whiskering (pending)



**For more information visit the
NASA TEERM Website:**

www.teerm.nasa.gov/

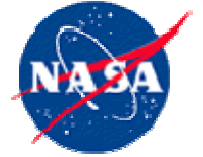
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Backup Slides



TEERM Project Process

